

The definition of industrialised building system construction essay



This review stage is to identify the definition and background information of Industrialised Building Systems in Malaysia construction industry. In order to achieve the objectives, a systematic literature review is to be conducted which will cover textbooks, institutional and statutory publications, periodicals and trade/academic journals, seminar and conference papers. For this project has brought a lot of information from CIDB Malaysia.

Industrialised Building Systems

Definition

Classification

Background information

Definition of Industrialised Building System (IBS)

Industrialisation process is an investment in equipment, facilities and technology with the objective of maximising production output, minimising labour resource and improving quality while a building system is define as a set of interconnected element that joint together to enable the designated performance of a building (Warswaski, 1999).

The industrialised building system (IBS) can be defined in which all building such as wall, slab, beam, column and staircase are mass produced either in factory or at site factory under strict quality control and minimal wet site activities. In another definition by Esa and Nuruddin (1998) claimed that IBS is a continuum beginning from utilizing craftsman for every aspect of construction to a system that make use of manufacturing production in order to minimise resource wastage and enhance value for end users. (Junid, 1986)

<https://assignbuster.com/the-definition-of-industrialised-building-system-construction-essay/>

clarified that elaboration of IBS whereby the IBS in construction industry includes the industrialised process which the components are conceived, planned, fabricated, transported and erected on site. The system balance combination between the software and hardware components. The software elements include system design which study the requirements of end user, market analysis, development of standardise components, establishment of manufacturing and assembly layout and process, allocation of resources and materials and definition of a building designer framework. The software elements provide a prerequisite to create the conducive environment for industrialized building system (IBS) to expand.

The hardware elements are categorised into three major groups which are include frame and beam system, panel system and box system. The framed structures are defined as those that carry loads through their beams and girders to column and to the ground whilst in panel system load are distributed through large floor and wall panels. The box system includes those system that employ threedimensional modules (or boxes) for fabrication of habitable units that are capable of withstanding load from various directions due to their internal stability.

Classification of IBS

The building system asserted by Warszawski (1999) can be classified into few types which are depend on the particular interest of their users and producers. The classification use construction technology as a basis for classifying different building systems. In this manner, four major groups can be distinguished such as system using timber, steel and cast in situ concrete and precast concrete as their main structural and space enclosing materials.
<https://assignbuster.com/the-definition-of-industrialised-building-system-construction-essay/>

These systems can be further classified according to geometrical configurations of their main framing components that are the linear or skeleton (beams and columns) system, planar or panel system and three dimensional or box systems. The Industrialised Building System (IBS) is a construction process that utilizes techniques, products, components or building systems which involved prefabricated components and on-site installation. From the structural classification, there are five IBS main groups that are used in Malaysia as shown below:-

- a) Pre-cast Concrete Framing, Panel and Box Systems
- b) Steel Formwork Systems
- c) Steel Framing Systems
- d) Prefabricated Timber Framing System
- e) Block Work System.

The pre-cast concrete components are among the most common prefabricated elements that are available both locally and abroad. The pre-cast concrete elements are concrete products that are manufactured and cured in a plant environment and then transported to a job site for installation. The elements are columns, beams, slabs, walls, 3-D elements (balconies, staircase, toilets, and lift chambers), permanent concrete formwork and etc.

The steel formwork is prefabricated in the factory and then installed on site. However the steel reinforcement and services conduit are installed on site

before the steel formwork are installed. The installation of this formwork is easy by using simple bracing system. Then concrete is poured into the formwork and after seven days, the formwork can be removed and there is some system whereby the formwork served as a part of the structure itself after concreting. The steel formwork systems are used in tunnel forms, beams, column moulding forms and permanent steel formworks.

The elements of steel framing system are rolled into the specific sizes and then the elements are fabricated that involves cutting, drilling, shot blasting, welding and painting. Fabricated elements are sent to the construction site to be then erected whereby welding and the tightening of bolts at joints are conducted. The elements include steel beams and columns, portal frames and roof trusses. The prefabricated timber framing system is normally used in the conventional roof truss and timber frames. The timber is prefabricated by joining the members of the truss by using steel plate. It is important that all members are treated with the anti pest chemical. Then, the installation is done on site by connecting the prefabricated roof truss to the reinforcement of the roof beams. The elements of block work system include interlocking concrete masonry units (CMU) and lightweight concrete blocks. The elements are fabricated and cured in the factory. The elements are normally used as bricks in structures and interlocking concrete block pavement.

Types of IBS

Based on structural aspects, IBS can be divided into five major

types (2):

••- Type 1: Pre-cast Concrete Framing, Panel and Box Systems

The most common group of IBS products is the pre-cast concrete elements – pre-cast concrete columns, beams, slabs, walls, “ 3-D” components (e. g. balconies, staircases, toilets, lift chambers, refuse chambers), lightweight pre-cast concrete, as well as permanent concrete formworks.

••- Type 2: Steel Formwork Systems

Considered as one of the “ low-level” or the “ least prefabricated” IBS, as they generally involve site casting and are therefore subject to structural quality control, the products offer high quality finishes, and fast construction with less site labour and material requirement. These include – tunnel forms, tilt-up systems, beams and columns moulding forms, and permanent steel formworks (metal decks).

••- Type 3: Steel Framing Systems

Commonly used with pre-cast concrete slabs, steels columns and beams, steel framing systems have always been the popular choice and used extensively in the fast-track construction of skyscrapers. Recent development in this type of IBS includes the increased usage of light steel trusses consisting of cost-effective profiled cold-formed channels and steel portal frame systems as alternatives to the heavier traditional hot-rolled sections.

••- Type 4: Prefabricated Timber Framing Systems

Among the products listed in this category are timber building frames and timber roof trusses. While the latter are more popular, timber building frame

systems also have its own niche market; offering interesting designs from simple dwelling units to buildings requiring high aesthetical values such as chalets for resorts.

• Type 5: Blockwork Systems

The construction method of using conventional bricks has been revolutionised by the development and usage of interlocking concrete masonry units (CMU) and lightweight concrete blocks. The tedious and time-consuming traditional brick-laying tasks are greatly simplified by the usage of these effective alternative solutions.

History

The concept of IBS is not new and can be traced back to as early as 1624 when panellised timber houses were shipped from England to the new settlements in North America (3). The Industrial Revolution of the 1700s provided the construction industry with technological boost. The construction of the first cast iron bridge across the Severn Gorge, at a place now known as Ironbridge in Shropshire, England, revolutionised the way structures were built. Then, numerous magnificent iron-based structures were constructed; including the modular-dimensioned Crystal Palace in Hyde Park, London for the 1851 Great Exhibition and the Eiffel Tower for the Paris World Expo and French Revolution Centenary Celebration in 1889. The development of steel and other pre-engineered materials promoted the race to build tall structures, particularly in the United

States where steel frames are often combined with pre-cast panels in building skyscrapers. While steel structures of road and railway bridges were

common in preindependence Malaya, the use of pre-cast concrete in the local construction industry arrived much later. In 1966, the Malaysian government launched two pilot projects - the Pekeliling Flats in Kuala Lumpur and the Rifle Range Road Flats in Penang; both using precast concrete elements to build these high rise low cost flats. Following these pilot projects, PKNS acquired pre-cast concrete technology from Praton Haus International,

Germany and built numerous housing projects ranging from low cost houses to high cost

bungalows from 1981-1993 (4). The success of pre-cast, steel and hybrid construction contributed to the rapid creation of numerous beautiful and quality structures; particularly during the 1995-1998 period.

These include the construction of the Bukit Jalil Sports Complex and Games Village, the Petronas Twin Towers and the LRT lines and tunnels. IBS's benefits are inherent in the beautiful structures of the Putrajaya precincts and in the projects to improve Kuala Lumpur's infrastructure. Others include the construction of elevated highways using pre-cast concrete box girders as well as the monorail lines utilising arched pre-cast concrete beams.

However, even after nearly four decades of introduction, it appears that the usage of IBS in Malaysia is still low compared to that of other developed countries such as Japan, UK, Australia and US. It is a loss for the local industry players as IBS offers solutions to the issues previously identified (5), which would definitely exert a major impact on the industry - productivity, quality, health and safety, and the environment.

<https://assignbuster.com/the-definition-of-industrialised-building-system-construction-essay/>

Strength, Weakness, Opportunity and Threat in IBS

The IBS construction is evaluated and there are several strength, weakness,

opportunity and threats in IBS that can be distinguished. All these factors can

impact the use of IBS in the country and therefore solutions of the problems need

to be tackled quickly as to encourage the use of IBS in this country.

2. 4. 1 The Strength of IBS

The new innovative construction system especially IBS has several advantages and positive effect to the construction industry in Malaysia.

Firstly, the use of IBS can reduce the dependency on foreign labours especially the semi skilled and the non skilled workers to approximately 40% to 50%. This also alleviates the problem of the shortage of foreign workers in Malaysia.

Next, the construction period using the IBS construction can be reduce and this can save valuable time and helps to reduce the monetary losses. The production of the IBS can start concurrently with the earthwork stage after the design has been confirmed. It is also unaffected by the weather conditions due to the controlled environment of the casting delay and this will eliminate the excusable delay in the conventional construction. In some projects, probably the speed of construction is not required in construction; instead a steady speed may be desirable due to other constraints such as financial decision at the top management level of construction.

The quality of the IBS is more secured because the manufacturer imposed strict quality control over the materials, production process, the curing temperature and etc. The concrete mix and the stripping time can be controlled and monitored closely and thus produces high quality components with high aesthetical value.

The use of IBS can greatly reduce the usage of conventional timber and therefore the environment will be preserved. Moreover, the process of producing IBS elements are designed to be repetitive and thus minimal wastage will be experienced at the factory and the construction site.

IBS elements provide a safety working platform for the workers to work on and therefore the risk on minor accidents to fatal accidents can be prevented. This is cause by the non congestion of workers and the reduction of waste on site.

Advantages of Industrialised Building System (IBS)

The conventional construction methods have been known and proven to be wasteful, dangerous and messy due to the process of constructing buildings. It is important for the Malaysian construction industry to evolve and be ready for the globalization era whereby increase of productivity, quality and safety are compulsory and the reduction of cost and construction period must be taken into account. The advantages of using Industrialised Building Systems (IBS) are:-

- a) Reduction of unskilled workers
- b) Reduce wastage

- c) Increase in quality
- d) Safer working environment in construction site
- e) Reduce construction period

Malaysian construction industry has been heavily dependant on the unskilled foreign workers especially from Indonesia, Bangladesh, Vietnam and etc. The absence of foreign workers during the Amnesty Programme launched by the government in 2005 have crippled most of the construction projects throughout Malaysia. This can hinder the development in this country and it can cause a huge loss in term of cost especially to the local developers and contractors.

Implementation of IBS can reduce the number of unskilled foreign workers in the construction industry and therefore the money siphoned by the foreign workers to abroad can be minimised and this will benefit the local economy. With less labour involved in the IBS construction, overall construction time is shorter. This will enable the constructor to save on the overhead cost involved in the construction.

The reduction of workers will enable workers to work at ease without much congestion involving several crews of workers at the same time such as concreter, brick layer, plasterer, carpenter, electrician, plumber and etc. Using the IBS construction, the service from concreter, plasterer, brick layer and carpenter is no longer needed on site but in the IBS factory and their site tasks will be replaced by

a group of assembler which consist about 5 persons per project compared to the conventional method.

The conventional construction methods normally generate about 20% of wastage in terms of cost. The usage of IBS elements eliminates or greatly reduces conventional timber formwork and props. This reduction will eventually minimize the use of timber and the forest can be saved from destruction. It also reduces the use of nail for the conventional formwork. Furthermore, the elements produced in the plant and mostly designed to be repetitive and thus minimal wastage will be experienced at the factory and construction site.

The IBS elements are manufactured in a shaded and environmental protected casting area where critical factor including curing temperature is taken into account. Temperature control is important to prevent structural cracking and to avoid weather related delays. The concrete mix design and stripping time can be controlled, monitored closely or accelerated using additives or steam curing. This will ensure that the qualities of the precast products are better than the cast in situ concrete.

The prefabricated products in the market provide a safe working platform for workers to work on. Prefabricated elements will greatly reduce the usage of nails and bricks which are the main cause of accidents in the country. The reduction of workers will enable workers to work at ease without much congestion involving several gangs of workers at the same time. In the conventional construction, brick laying is started as soon the strip form is completed. However, in the some cases, the bricks will arrive on site before

strip form. This will cause the congestion between the carpenters and the brick layer and thus the workers are at risk of falling formwork.

The IBS construction will save valuable time and helps to reduce the risk of project delay and possible monetary losses. The design and production of elements can be started while the construction site is under survey or earthwork.

The production of the IBS elements are unaffected by weather conditions due to the controlled environment of the casting area. The usage of large structural panels speed up the structural works and thus other trades such as painting, electrical wiring and plumbing works can begin work sooner. The average delivery time for a complete house using IBS construction is approximately 3 to 5 months whereby the conventional system takes about 18 months to complete.

2. 4. 2 Weakness in IBS

There have several weaknesses that can be discover in the implementation of IBS. The IBS construction requires a high initial investment capital for the purchase of machineries, steel mould, foreign technology, transportation and the wages of skilled workers for the installation process. The use of IBS need the governance of a particular organisation which cost a lot of money in terms of standardisation of sizes, improve the building regulations through research, quality of the products and others. The extra cost also involved in the training of foreign unskilled and semi skilled labourers to enable them to involve in the IBS construction process. However, the training will be in vain

if the workers decided to go back to their country and the constant change of workers and the retraining of new workers will be wasteful.

The IBS will enable the contractors and manufacturers that implement this technology to monopolise the market. This is because many companies are still reluctant to change due to the high investment cost. Then the small and medium industries that are reluctant to change will be affected and this will result in an unhealthy competition among them.

The site condition will also affect the use of IBS. Since the IBS components are transported to the site and involved heavy machineries for the installation process. The site must have fair road surface and temporary site access for heavy vehicle and therefore a lot of money will be spend on improving the road conditions and crusher run need to be laid to improve the existing site access ground condition. The distance between the site and the factory must be considered for the most economic time for the manufacturing plant to rotate the loading and unloading period.

Lastly, the transport used to carry IBS components need to be redesign to be able to carry larger panels. Lorries that are redesigned must meet the suitability and at the same time to follow the road regulations. Currently, the transporters can carry limited weight, length and depth of IBS components stated in the road regulations therefore the optimum carrying capacity is not met.

Formwork

1. Purpose and Use of Formwork

The formwork serves as mould for concrete structural components unless such mould is provided by the soil,

other structural components, etc. It moulds the placed fresh concrete, which in this stage normally is viscous,

to the shape specified in the drawing.

Consequently, the formwork must already be available when the necessary steel reinforcement and concrete

mix are placed. Proper making of formwork decides on the accuracy to size, strength and surface finish of the

concrete components. Formwork is required wherever monolithic concrete and reinforced concrete structures

or structural components are constructed, such as for

• solid structures (foundations, columns...),

• structures with special functions (containers, chimneys, hydraulic structures ...),

• structures to meet great statical requirements (bridges, towers...),

• reconstruction of structures,

• public buildings and structures of irregular arrangement.

Generally, each formwork is of provisional nature and is to be removed after hardening of the concrete placed.

The formwork is not to be built as strong as possible but as strong as necessary only!

Therefore, formwork stripping must always be kept in mind when erecting the formwork.

To avoid unnecessary difficulties of work and prevent damage from formwork parts, the following

recommendations should be followed:

â Do not drive in too many nails.

â Use only as many timbers, braces, tie wires, etc. as necessary.

â Consider, which board, panel or squared timber is to be stripped first, to fix them so as to

permit easy removal in the proper sequence.

Formwork making guaranteeing the necessary strength but also considering aspects of economical use of

material and easy formwork stripping calls for extensive specialized knowledge of the direction of forces when

placing the concrete mix.

Improperly made formwork, which gives way or breaks when the concrete is placed, results in heavy material

damage or, in the worst case, may cause serious injury of persons.

On the other hand, an excessively strong formwork requires high physical efforts of the persons stripping the

formwork and normally results in the complete destruction of the formwork parts.

2. Functional and Load Requirements of Formwork

Formwork functions

The formwork is the main means of work in the moulding process of the concrete. Basically the process of

formwork making has to meet the following requirements:

â' The structural component to be produced is to be moulded with the projected dimensions

keeping the admissible tolerances.

â' The dead loads of the fresh concrete and of the reinforcement as well as the temporary

load of persons and working tools must be safely resisted and carried off to the soil or

supporting members of the structure.

â' The concrete must be protected against too high or too low temperatures as well as

vibrations.

â' The thin concrete mix must not flow out of the formwork.

â' The future concrete component must have a surface finish meeting the required quality

after stripping.

â' The placement of necessary steel reinforcements must be easily possible during the

erection of the formwork.

â' Stripping of the concrete components produced must be uncomplicated.

What are the basic principles of formwork making?

Loading of vertical formwork

Vertical formwork is used for strip foundations, concrete walls and columns.

Immediately after placement in the formwork until achievement of its inherent stability, the concrete mix, under

the effect of its own load and of compaction by vibration, exerts lateral pressure on the formwork which is

called lateral pressure of the concrete mix.

The lateral pressure of the concrete mix depends on the following factors:

• Composition and properties of the concrete mix (density, type of cement, quality of

concrete),

• concrete placing technology (concreting speed, compaction, vibration depth, total height of

the concrete mix)

• ambient conditions (temperature, air humidity).

Tie wires (tie rods) are used to take up the lateral pressure of the concrete mix. They are to be included in the

formwork project.

The maximum lateral load with external vibration occurs at the foot of the formwork and with internal vibration

above the foot.

In addition to the lateral pressure of the concrete mix, the concrete mix also produces buoyant forces which

may cause lifting of the formwork. This can be the case particularly with foundation formwork. To avoid this,

the formwork is to be anchored in the subsoil.

Another way is loading the formwork by means of concrete parts.

Advantages of Steel Frame

Lightweight steel frame is faster to erect than timber frame, fireproof, and highly

accurate as it is factory-produced and transported to the site in sections. As it is strong

it allows for large internal open plan spaces. It also appears to compare very favourably

in price with what is generally recognised as the cheapest means of building – dual

skinned blockwork. Some systems allow for the sections to be produced and assembled

on site. Insulation is easily installed: some systems have walls with a U-value of 0.7 and

houses built in this fashion are easy to extend and modify.

Disadvantages of Steel Frame

The main one appears to be public perception. Despite the fact that thousands of homes

have been built in this way in other countries British people somehow seem to think it is

both expensive and in some way difficult to achieve. Neither is true.

The other obvious disadvantage is sound transmission. Steel framed houses are

potentially poor from the point of view of sound transmission. In the case of airborne

sound this can be overcome by packing the frame with quilting. In social housing with

party walls, impact sound, which is transmitted through the floors, can present more of

a problem. However in individual self-builds, where the floors are of timber or chipboard, this is less of a problem as the noisy elements can be isolated and dealt with

individually.

One company experienced in steel frame construction that is now turning its sights to

the self-build market is Cressey Engineering. They claim to be able to build a complete

150m² house in 12 weeks at a cost of around £550/m² all in.

<https://assignbuster.com/the-definition-of-industrialised-building-system-construction-essay/>

Another young company, Bristol-based Metek Building Systems uses steel rolling

machinery that can be transported onto site to convert steel coils into cold-rolled steel

frames for fast track buildings. In the housing field this has so far only been used for

social housing but the company is also now looking at the self-build market.

Managing

director Dr Alan Rogan quotes a price of £30/m² for finished wall frames. The company

can also supply full insulation and a choice of a brick slip or rendered walls.

They do not

generally supply roofing systems. “ There are no real disadvantages with this system,” Dr

Rogan says. “ We can offer bespoke frames extremely quickly – sometimes within 24

hours – the system is very good thermally and acoustically and also easy to extend.”

Advantages of Timber Frame

Timber frame systems have always been popular with self-builders because they are fast

<https://assignbuster.com/the-definition-of-industrialised-building-system-construction-essay/>

and convenient. With the main components assembled in the factory and transported to

the site, the roofs and walls go up far quicker than with a conventional masonry system.

A timber frame structure can be erected and weathertight within a matter of days and

work can begin on first fix inside whilst the roofers start on the tiling.

Another advantage is that you can often deal with just one company, which will design,

manufacture and erect your timber frame. Very often the company will also supply the

roof structure, windows and doors.

Timber frame houses are also excellent from an insulation point of view.

Nowadays the

standard timber frame sections of 89mm have to be augmented by extra insulation on the

inside in order to conform with the U-value requirement of 0.35. However many

companies are now offering 140mm as standard, a practice which some timber framers

refer to as “ super insulation.”

Many self-builders also like the idea of living in a house where the main frame is

constructed from a sustainable resource where the timber source is guaranteed to have

come from renewable, carefully managed forests.

However, if timber frame is your choice you should remember that the law of diminishing

returns applies: the energy savings achieved by super-insulated walls are surprisingly

small and should be balanced against not just installation costs but loss of internal

floor space in situations where the planners dictate a maximum area for the footprint of

the house.

Disadvantages of Timber Frame

With most masonry systems the materials are readily available. Once you have your

planning permission and have found a builder you can get the materials very rapidly

and start. With timber frame a waiting period of 12 weeks is not unusual.

Beware, too, of

hanging heavy objects on the inside walls. If you wish to turn the inside of your house

into a picture gallery then timber frame, with its lightweight stud walls covered with

plasterboard, is not for you - although this problem can be largely overcome for a few

hundred pounds by the use of fibre reinforced plasterboard. Another possible

disadvantage is that unless you have high quality labour it is very easy in timber framed

houses with brick outer skins to get water penetration round window and door

openings.

Timber frame is also usually more expensive than brick and block, although most

timber frame companies would argue that if a self-builder opts for 140mm stud walls,

which give a U-value of less than 0.30, the additional costs will generally be recouped in

a few years by reduced heating costs.

Others argue that timber frame is acoustically inferior to brick and block. The fact that

with timber frame the walls are largely hollow counts against it when it comes to sound

proofing. However this is a tricky one because sound travels in two ways - through the

air and through impact. While masonry will tend to absorb airborne sound better

because it is denser than timber frame, impact sound can be transmitted through all

kinds of materials and there are many cases of masonry houses built with heavy

concrete intermediate floors which have failed to meet the impact sound requirements

of the Building Regulations. Good detailing in timber frame housing can reduce the

effect of airborne sound transmission so that it matches the best a masonry house can

achieve. It is also possible to add further products specifically designed to improve

sound insulation, but these all add to the cost of the house.

Timber frame construction using panels do